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(54) **Constructing gas discharge displays**

(57) A method for constructing a gas discharge display without an exhaust tubulation. The face plate 10 and base plate 12 which form the envelope of a display device are assembled as indicated in Fig. 1 in a vacuum furnace, not shown, the face plate being provided with a ring 32 of sealing frit having an irregular surface. These irregularities leave gaps between the frit and the base plate 12 which communicate with the interior of the gas display device and allow evacuation of the envelope and the subsequent introduction of a gas filling. The frit is then melted to secure the plates and form an hermetic seal. The frit may be preglazed to remove organic contaminants, and may contain glass spheres to provide correct plate spacing. Spring clips (34 Fig. 2 not shown) may be provided to assist plate positioning and adhesion during manufacture.

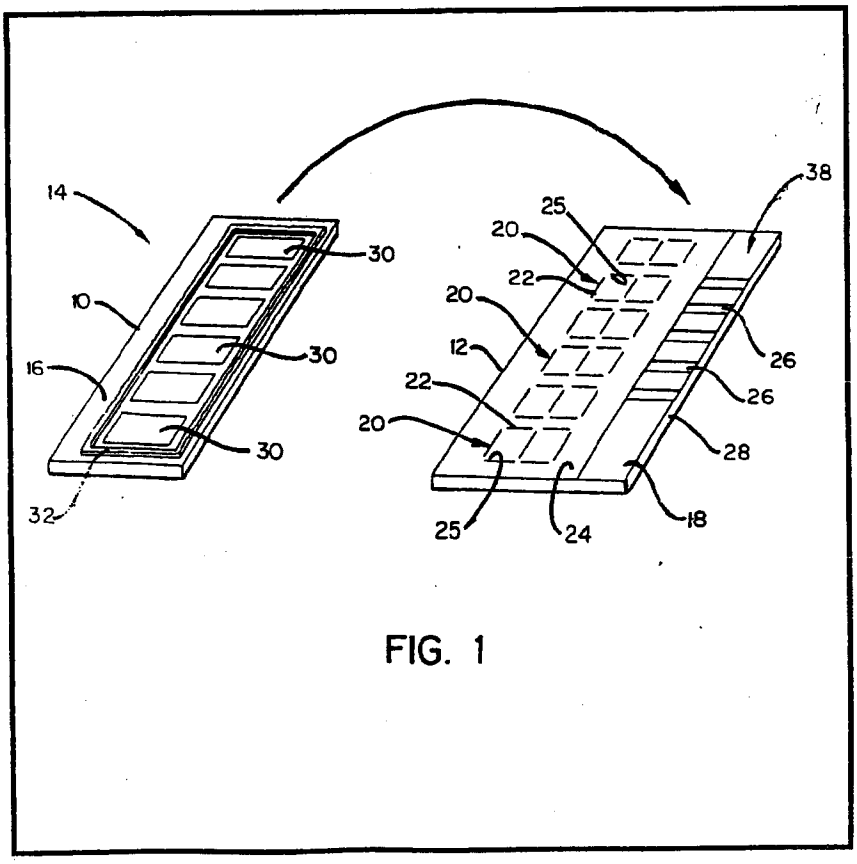

FIG. 1

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FIG. 1

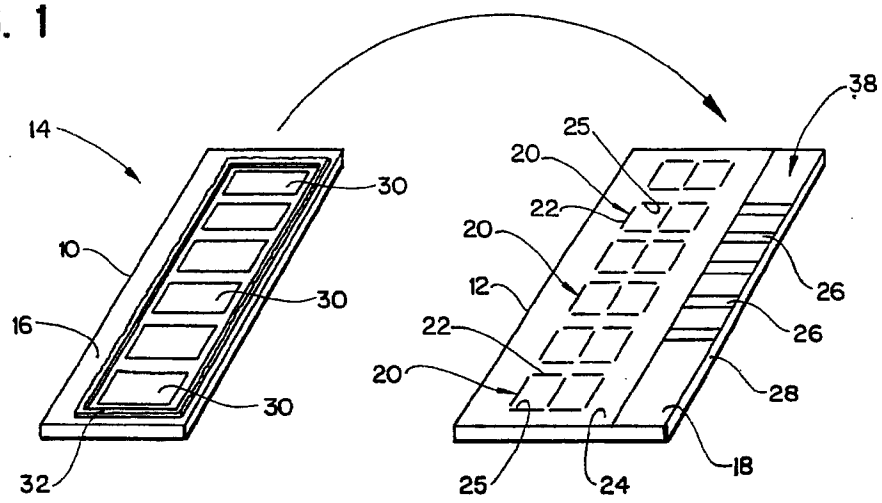


FIG. 2

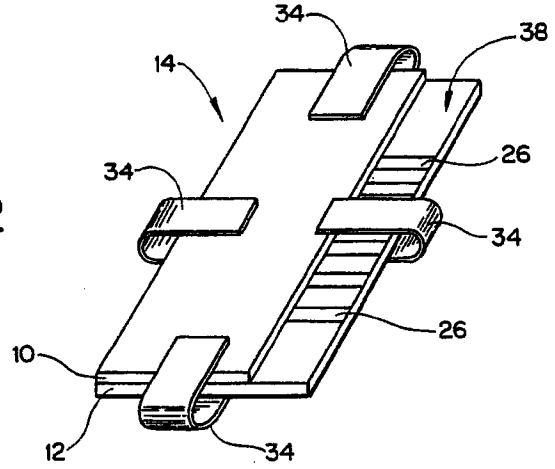


FIG. 3

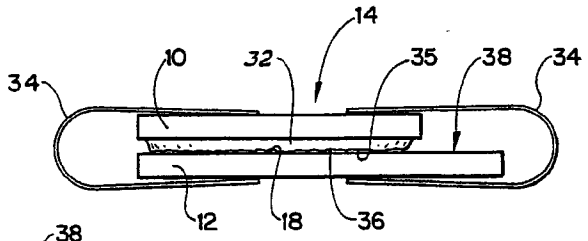
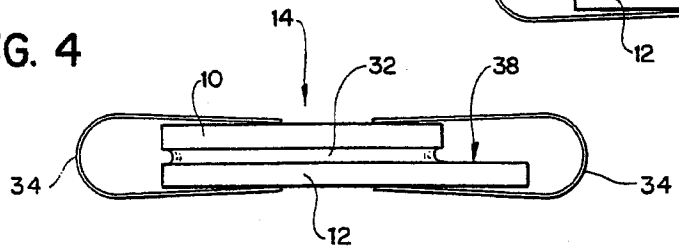


FIG. 4



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SPECIFICATION

Improvements in and relating to gas discharge displays

The present invention is directed to making a gas discharge display device without an external tubulation and more particularly is directed to a method of making a gas display device having no tubulation in a more efficient manner and with an improved seal.

The commonly used method for constructing a gas discharge display device incorporates the use of a tubulation port in one of the plates that forms the display device. A rather fragile tubulation glass channel extends away from the display plate adjacent the tubulation port to provide a channel for the evacuation of the envelope in the display device and for the subsequent introduction of an ionizable gas. Once the display is filled with an ionizable gas at the proper pressure, the tubulation member is pinched off to seal the display. However, a significant portion of the tubulation member remains attached to the display device presentin a projection exterior to the display device essentially perpendicular to the plane of the display device. Being made of glass material, the projecting tubulation is extremely fragile and is susceptible to breakage during packing, transporting or use of the display device. Consequently, many displays must be repaired or scrapped when breakage of the tubulation occurs.

Because of the utilization of a tubulation tube on a gas discharge display device presents a very fragile member in the device, various approaches have been utilized to avoid incorporating the tubulation member. In one approach a gap is left in the sealing frit material around the perimeter of the viewing area of the display device to provide an exhaust port for evacuating the envelope and an entry port to fill the envelope with the ionizable gas. After the filling of the envelope with the ionizable gas the gap in the sealing frit is sealed with a sealing material or low melting glass plug which is melted to enclose the gap. Examples of such an approach are shown in the Kupsky 4,009,407, Hinson 4,013,912 and Przybylek 3,980,366 patents.

Another approach has been to plug the tubulation port with some type of sealing material which is heated to enclose or plug the tubulation port leaving no tubulation extending from the exterior surface of the plate. An example of such arrangements are shown in the Beckerman et al. 3,914,000 patent and patent application 863,277 filed on December 22, 1977 by Frankland et al. entitled METHOD OF SEALING GAS DISCHARGE DISPLAYS.

Another approach to eliminating the utilization of a tubulation member on the gas display device is shown in the Wilson 3,778,126 patent wherein a sealing material initially has a permeable characteristic so that envelope evacuation and gas introduction can be done through the sealing material after which the device is heated sufficiently to melt the sealing material and seal the gas within the envelope.

Although many of the above described approaches eliminate the utilization of a tubulation member on the gas display device, each has certain relative disadvantages. The use of a separate sealing material to plug a gap in the frit of the display device requires special equipment to properly orient the sealing element as well as proper controls or even the use of special heating equipment to provide the necessary heating of the sealing plug. The requirement of special equipment to heat the sealing plug is especially true with respect to the Beckerman patent which utilizes a separate small heating unit which must be placed adjacent the sealing plug to cover the exhaust port in one of the plates of the display.

In most of these approaches the sealing time for the display is considerably longer than desired and in many instances the sealing frit is not properly prepared to provide a satisfactory and reliable seal. Also, in many of the above disclosed approaches the evacuation and gas filling of the display envelope require special equipment connected to each of the display devices.

Summary of the Invention

The present invention is a method for making a gas discharge display device having a face plate and a back plate forming an envelope containing display electrodes, said display having a viewing window, said method comprising the steps of: placing a sealing frit material on one of said plates around the perimeter of said viewing window; assembling said plates in face-to-face relation to form said envelope, said frit material having an irregular surface and forming in conjunction with the other of said plates a plurality of passages between the exterior and interior of said envelope; evacuating the atmosphere within said envelope through said passages; introducing an ionizable gas into said envelope through said passages; and heating said frit material to seal said plates hermetically and eliminate said passages to form a display with no exhaust aperture in said plates.

The invention eliminates the need for a tubulation projecting from the display. The preferred process of the present invention prepares the sealing frit in such a manner that it is preglazed in an air or oxygen environment to remove any organic binders from the sealing frit, so that, when it is heated for sealing between the plates of the display, a reliable and permanent seal is established. Without the use of the preglazing process, the frit upon melting may have a porosity which

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would result in a non-hermetic seal. It may, however, be possible with certain frits to omit the preglazing process and still obtain a satisfactory result.

It is also preferred to utilise biasing means attached between the plates when they are assembled in face-to-face relation so that during the heating step to provide the seal between the plates the time required is significantly reduced and the seal is greatly improved.

The irregularities in the sealing frit prior to its heating for sealing provides the necessary passageways for the evacuation and filling of the envelope in a vacuum furnace prior to the sealing of the plates. It is preferred to use a vacuum furnace which allows for the simultaneous evacuation and filling of several display devices without the need of any special connecting equipment between each display and a vacuum source as well as an ionizable gas source.

Consequently, the present invention not only eliminates the use of a tubulation in the device, but also eliminates the requirement for a special aperture in either of the plates or in the sealing frit as an evacuation and gas filling port.

In summary, the preferred form of the present invention teaches a method for making a gas display device without a tubulation member in such a manner that not only the time, but also the temperature required to seal the plates is reduced, and the frit is prepared in such a manner that it will create a reliable and hermetic seal between the plates which is extremely important to the gas filled envelope of the display.

Brief Description of the Drawings

Figure 1 is a perspective view of a display device prior to assembly of the plates, showing the interior surface of each of the plates;

Figure 2 is a perspective view of the plates assembled in a display device with biasing means attached to the plates;

Figure 3 is an enlarged end view with one of the biasing means removed showing the irregularities of the sealing frit prior to heating of the sealing frit to sealed plates; and

Figure 4 is an enlarged end view of the device similar to Fig. 3 showing the sealing frit after it has been heated to create the seal between the respective plates.

Detailed Description of the Invention

In Fig. 1 the face plate 10 and the base plate 12 of a gas discharge display 14 are shown prior to assembly with the interior surfaces 16 and 18 of the respective face plate 10 and base plate 12 exposed. Located on the interior surface 18 of the base plate 12 is an electrode pattern comprised of a plurality of character positions 20 formed by a series of separate cathode electrode segments 22. A dielectric layer 24 covers the electrode conductive runs which have been screened on the base plate 12 to properly interconnect the appropriate cathode segments 22 with the terminal pads 26 located along the longitudinal edge 28 of the base plate 12. Both the electrode pattern and the dielectric layer 24 are preferably screen printed on the interior surface 18 of the base plate 12.

Deposited on the interior surface 16 of the face plate 10 are a plurality of anode electrodes 30 which are designed to operate in conjunction with each of the character positions 20 on the base plate 12. The anodes 30 are preferably made of a transparent material such as tin oxide. Each of the anodes 30 is connected to a respective terminal pad 26 by a clip (not shown) placed between the plates. Located around the periphery of the anodes 30 is a sealing frit 32. The sealing frit 32 is preferably screen printed onto the face plate. One preferable material is Corning 7575 frit although Corning 7555 is another frit material to use. Glass beads, not shown, are in the sealing frit so that, when the frit melts, the glass beads will establish the necessary spacing between the plates when they are assembled. It should be noted that the cathode electrodes 22 and the anodes 30 could be placed on the base plate 12 in a coplanar relationship.

Once the cathode electrodes 22, the anode electrodes 30, the dielectric layer 24 and the sealing frit 32 have been properly placed on the respective interior surfaces 16 and 18 of the plates 10 and 12, the face plate 10 is placed in face-to-face relationship with the base plate 12 to assume the orientation shown in Figs. 2. However, prior to this step, the frit material has been preglazed or heated in an air or oxygen atmosphere to remove any organic binders in the frit as will be explained later with respect to the overall method of assembly of the present invention.

In order to provide tight engagement between the face plate 10 and the base plate 12 in Fig. 2 a plurality of biasing clips 34 are placed around the display device 14. Depending upon the size of the display device either two or four biasing clips 34 can be utilized. As shown in Fig. 3, which is an end view of the display 14 with the end biasing clip 34 removed, the sealing frit has an irregular surface 35 which in conjunction with the interior surface 18 of the base plate 12 forms a plurality of vias or openings 36 which permit the evacuation of the interior evelope formed between the face plate 10 and base plate 12 in conjunction with the sealing frit 32. Further, the vias or openings 36 can be utilized for the introduction of an ionizable gas into the envelope prior to sealing of the frit 32.

It should be noted that the base plate 12 is wider than the face plate 10 to provide an

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extended portion 38 of the base plate 12 on which the connection or terminal pads 26 are situated to create an edge board connection to the electronic circuitry of the device in which the display is to be utilized.

Turning to the more detailed explanation of the method or constructing the gas discharge display device 14, attention is directed to Fig. 1. A plurality of cathode electrodes 22 with a series of electrode conductive runs (not shown) are screen printed on the interior surface 18 of the base plate 12. Further, the terminal pads 26 which connect to the conductive runs are deposited along the extended portion 38 of the base plate 12. Subsequently, a dielectric layer 24 is placed over the electrode conductive runs. The dielectric layer 24 has a plurality of apertures or windows 25 which allow for the exposure of the cathode electrode segments 22 to form the character positions 20. Depending upon the complexity of the character position more than one conductive layer and dielectric layer may be necessary.

The face plate 10 in Fig. 1 has a plurality of anode electrodes 30 deposited on the interior surface 16 with each anode electrode 30 designed to operate cooperatively a respective character position 20 on the base plate 12. Although the present invention shows the anode electrodes 30 being placed on the face plate 10, it should be noted that in some arrangements it may be desirable to incorporate the anodes on the base plate 12 to provide a coplanar anode and cathode electrode arrangement. Deposited on the interior surface 16 of the face plate 10 is a glass frit 32 which is preferably screen deposited. Located within the frit 32 are a plurality of small spacer beads (not shown) which have a higher melting point than the frit material and are designed to provide the necessary spacing between the face plate 10 and the base plate 12 when the plates are assembled in face-to-face relation.

Prior to the assembly of the face plate 10 and the base plate 12 in face-to-face relation, the glass frit 32 is preglazed or heated by placing the face plate 10 in an oxygen or atmosphere furnace and heated to remove or burn out any organic binders which may be in the glass frit material. Otherwise, the presence of binders within the glass frit would establish or create a porous sealing material when the frit is subsequently heated to seal the plates hermetically together. In other words, if the binders were burned out at the time that the plates are assembled and the frit is heated to seal the plates, the removal of the binders may result in the existence of voids within the frit which could result in leakage of the ionizable gas from within the display envelope and could contaminate the gas.

After the preglazing step on the frit material 32, the plates are assembled in face-to-face relationship with respect to each other to assume the position or configuration shown in Fig. 2. As stated previously, the width of the face plate 10 is less than the width of the base plate 12 so that a protruding edge portion 38 on the base plate to support the terminal connection pads 26 for insertion into the electronics of the device in which the display is to be utilized. After the plates are properly oriented with respect to each other, a plurality of the biasing or spring clips 34 are positioned around the display device 14. Depending upon the size of the display device, two or four of these clips 34 may be utilized. The clips not only maintain the proper orientation between the plates, but also provide for increased pressure between the plates. The pressure of these clips reduce the temperature and the time required for the sealing step when the frit material is heated to provide the seal between the plates.

However, prior to the heating of the frit material for sealing the plates together, the device 14 is inserted into a vacuum furnace wherein a vacuum environment is created to withdraw or evacuate the atmosphere within the envelope created between the plates and the frit material 32. Since, as shown in Fig. 3, the frit material prior to its heating for sealing has an irregular surface 35 to create a plurality of vias 36, the atmosphere within the envlope can easily be withdrawn. After the vacuum environment has been created, an ionizable gas is introduced within the furnace to fill the envelope between the plates through the vias 36. After the ionizable gas has filled the envelope at the proper pressure, the vacuum furnace temperature is raised to the point where the sealing glass frit is melted and devitrified to create a hermetic seal between the plates. As stated previously, located within the frit material are glass beads having a higher melting temperature than the glass frit and will provide the necessary spacing between the plates as the frit material devitrifies. The utilization of the biasing clips 34 greatly decreases the time and temperature necessary to create the hermetic seal by the melting of the glass frit.

By way of example, once the display device 14 has been placed within the vacuum furnace, the temperature is increased to approximately 350°C while the vacuum is being created. The vacuum is held for several minutes after which the temperature is again raised to 480°C during which time the introduction of the ionizable gas occurs. Once a temperature of 480°C is reached, it is held for approximately 20 minutes to provide for the devitrification of the glass frit. The furnace is then allowed to gradually cool from 480°C to 330°C for approximately 40 minutes and nitrogen is injected into the furnace to approximately one atmosphere to aid in cooling. Finally the displays are cooled to approxi-

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mately 100°C and removed from the furnace.

It will be appreciated that while the preferred process for making the gas display has been described, cognizance should be taken of the fact that it would be apparent to those skilled in the art that certain obvious modifications such as the use of a vitreous frit may be made to the present invention without departing from the true spirit and scope of the claims set forth.

CLAIMS

1. A method for constructing a gas display device having a face plate and a back plate forming an envelope containing display electrodes, said display having a viewing window, said method comprising the steps of: placing a sealing frit material on one of said plates around the perimeter of said viewing window; assembling said plates in face-to-face relation to form said envelope, said frit material having an irregular surface and forming in conjunction with the other of said plates a plurality of passages between the exterior and interior of said envelope; evacuating the atmosphere within said envelope through said passages; introducing an ionizable gas into said envelope through said passages; and heating said frit material to seal said plates hermetically and eliminate said passages to form a display with no exhaust aperture in said plates.

2. A method as defined in claim 1 and after said assembling step additionally comprising the step of attaching biasing means to said plates to force said plates into tighter engagement with each other so that the time and temperature required to seal said plates as compared to the time and temperature required to seal said plates without said biasing means is reduced.

3. A method as defined in claim 1 or claim 2 and after said placing step additionally comprising the step of preglazing said frit material to remove organic binders within said frit material.

4. A method as defined in any preceding claim, wherein said evacuating and said introducing steps are accomplished in a vacuum furnace.

5. A method as defined in any preceding claim, wherein said frit material is a glass and devitrifies during said heating step.

6. A method as defined in any peceding claim, wherein said frit material contains glassbeads having a higher melting temperature than said frit material so that during said heating step said glass beads establish the proper base plate and back plate spacing.

7. A method as defined in claim 2, wherein said biasing means comprises compression springs which are connected to both the face plate and the back plate during said attaching step to hold said plates in tight engagement with each other,

8. A method for constructing a gas display device, substantially as hereinbefore described with reference to the drawings.

9. A gas display device constructed by the method of any preceding claim.

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